Project Proposal

Stereo Reconstruction With Relative Pose Estimation

1 Abstract

Our goal is to implement an algorithm to obtain the 3D geometry of a scene via *Stereo Reconstruction*. We assume that the images are undistorted and that the intrinsic parameters of the cameras that were used to record the two views are provided. However, we will not require the offset between the two view optical centers to be known, which must therefore be inferred by our algorithm. While this makes the algorithm more complex, it allows reconstruction to be performed on a much larger variety of input image pairs. As long as the relative pose difference between the two views is suitable for stereo reconstruction, our algorithm will be able to reconstruct 3D information. This provides the ability to use a single camera to record two images with a small pose offset and to perform reconstruction, though the approach could easily be extended to allow the user to use true stereo images with a known relative pose difference for the reconstruction whenever this information is available.

The processing pipeline (Fig. 1) is therefore split into two main stages: (1) In the first stage we determine the relative pose difference between the two views. To this end, we will first use feature descriptors such as **SIFT**[1] and **ORB**[3], to find suitable feature points in the two images. Then we will use feature point matching based on **FLANN**[2] and brute-force methods to obtain corresponding feature points in the images. This information allows us to retrieve the essential (or fundamental matrix) and relative pose between the two views' optical centers. (2) Followingly, we will rectify the two images and compute the disparity map between them. This information, combined with the essential matrix we computed in Step 1, enables us to re-project the feature points into 3D coordinates. These 3D points will then represent a point cloud that could either be written directly to a point cloud file or be used to reconstruct the actual 3D geometry by performing surface reconstruction.

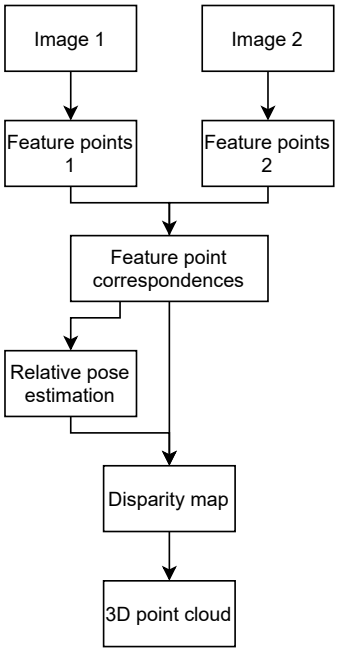

Figure 1: Project pipeline

2 Requirements

Datasets: Multiview Datasets, Middlebury Stereo Datasets
Libraries: OpenCV

3 Team

The team consists of 4 students: Jiesheng Ding, Atilla Alpay Nalcaci, Benjamin Rickels and Siyuan Shen

4 Milestones

- Week 1: Exploration of suitable feature points and feature point correspondences in the two images and use these to perform stereo calibration. (i.e. to estimate the relative pose difference between the camera optical centers of the two images.)
- Week 2: Reutilization of previously computed feature point correspondences to compute the disparity map of the two images.
- Week 3: Implementation of the 3D Point Cloud Reconstruction using the disparity map; potentially perform surface reconstruction.
- Week 4: Research and analyze addi-tional feature point descriptors and matching methods, and evaluate how they affect the obtained results.
- Week 5-6: Testing of the algorithm on additional input image-pairs from different datasets and images to analyze its performance in different situations. Consequently contemplating if the different feature point extractors and matchers explored in Week 4 can be used to obtain better results in certain situations.

References

[1] David G Lowe. Distinctive image features from scale-invariant keypoints. *International journal of computer vision*, 60(2):91–110, 2004.

[2] Marius Muja and David G Lowe. Fast approximate nearest neighbors with automatic algorithm configuration. *VISAPP (1)*, 2(331-340):2, 2009.

[3] Ethan Rublee, Vincent Rabaud, Kurt Konolige, and Gary Bradski. Orb: An efficient alternative to sift or surf. In *2011 International conference on computer vision*, pages 2564–2571. Ieee, 2011.